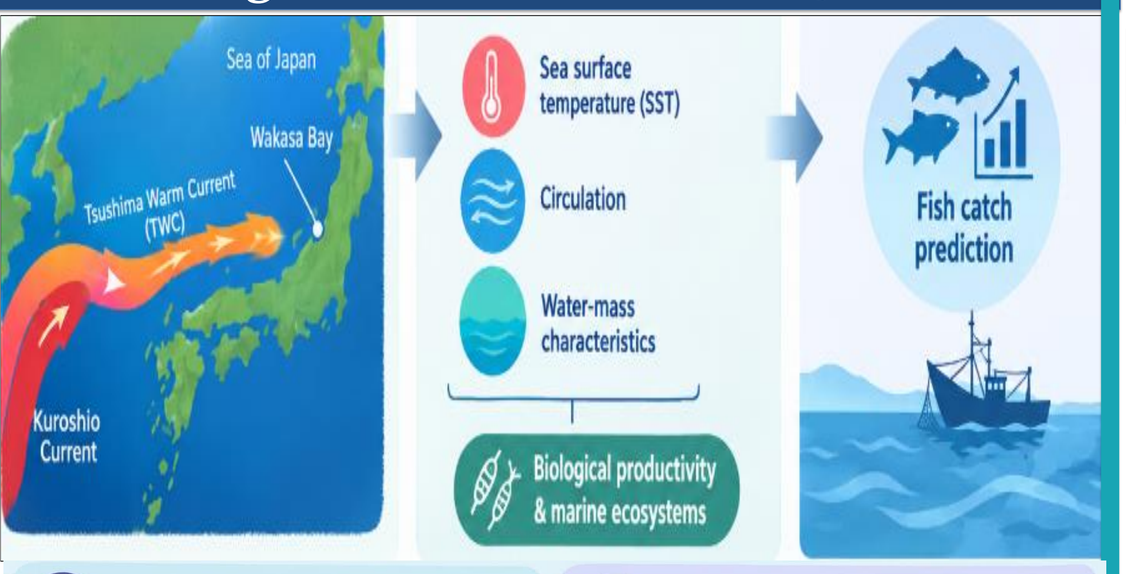
Spatiotemporal Variability in the Hydrographic Structure of Wakasa Bay, Japan under the Influence of the Kuroshio–Tsushima Current System

PICES-2026
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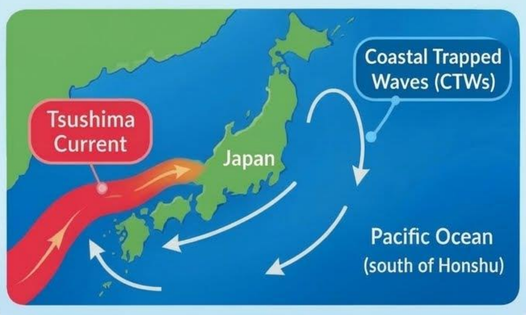
Katha Mukherjee[1], Takeyoshi Nagai[1]
[1]Tokyo University of Marine Science and Technology, Tokyo, Japan
Email: mukherjeekatha17@gmail.com



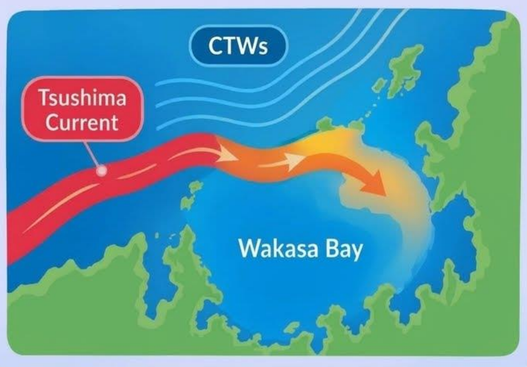
1. Background and Research Questions



1 Does the Tsushima Current get affected by coastal trapped waves (CTWs) propagating around the Japanese coast from the Pacific Ocean south of Honshu?

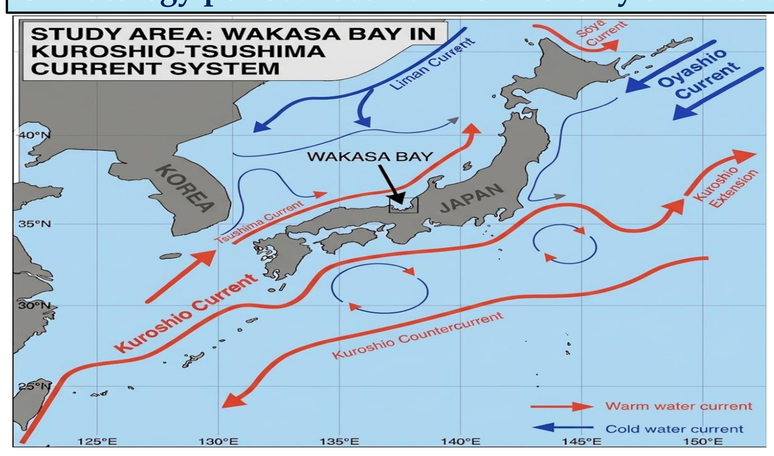


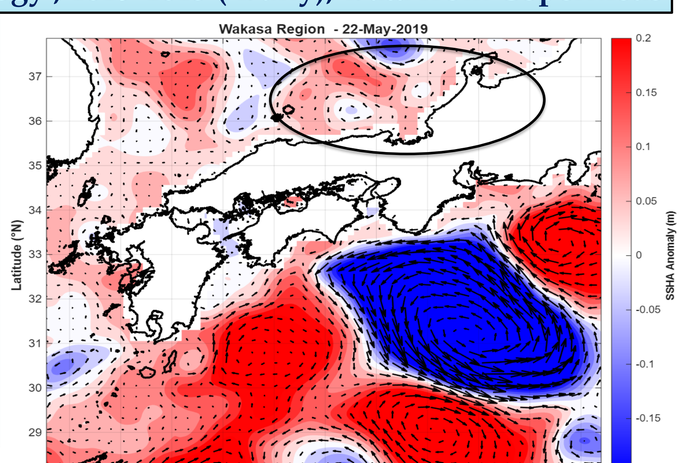
2 If yes, do the warm water intrusions into Wakasa Bay from the Tsushima Current also get affected by these CTWs?

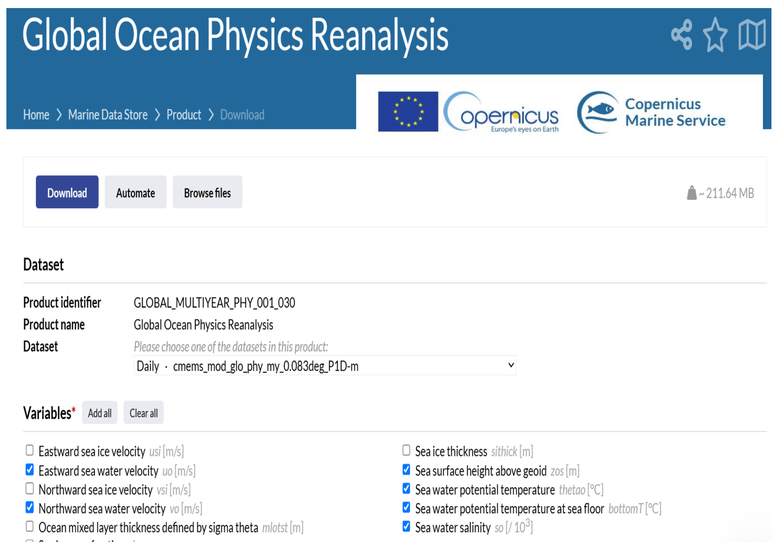


2. Study Area and Method

Figure: Region analyzed: 128–142°E, 30–40°N (basin scale) and 133.5–138.5°E, 34.5–39°N (bay scale), Climatology period: 2000-2022 for monthly climatology , 2019-2023 (Daily), Data from Copernicus





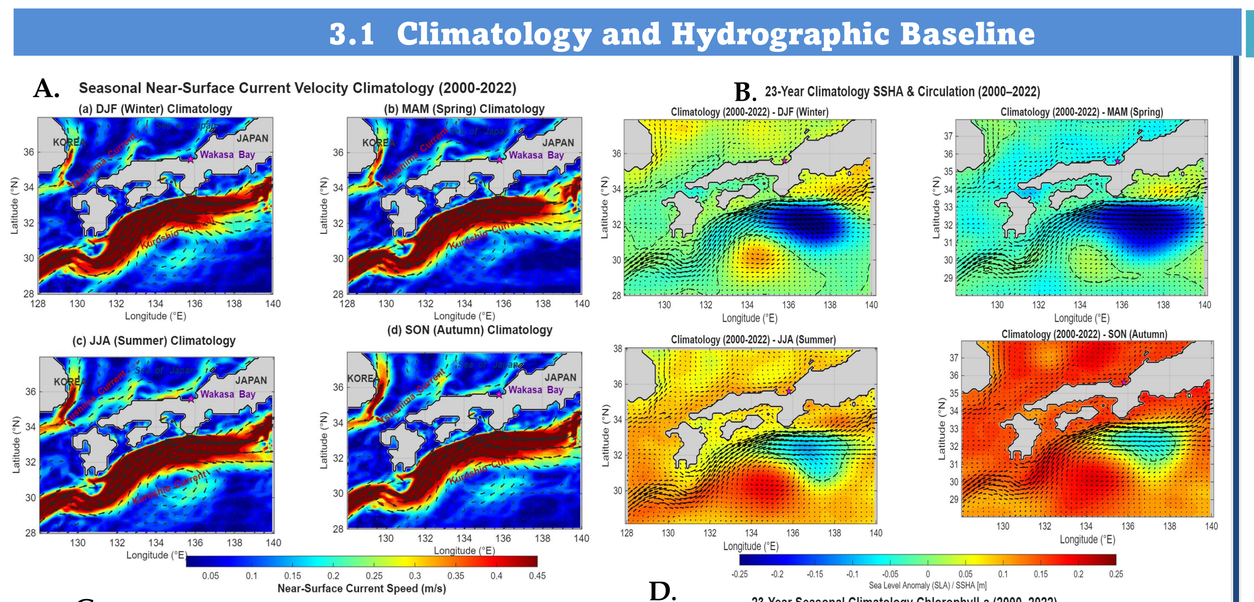


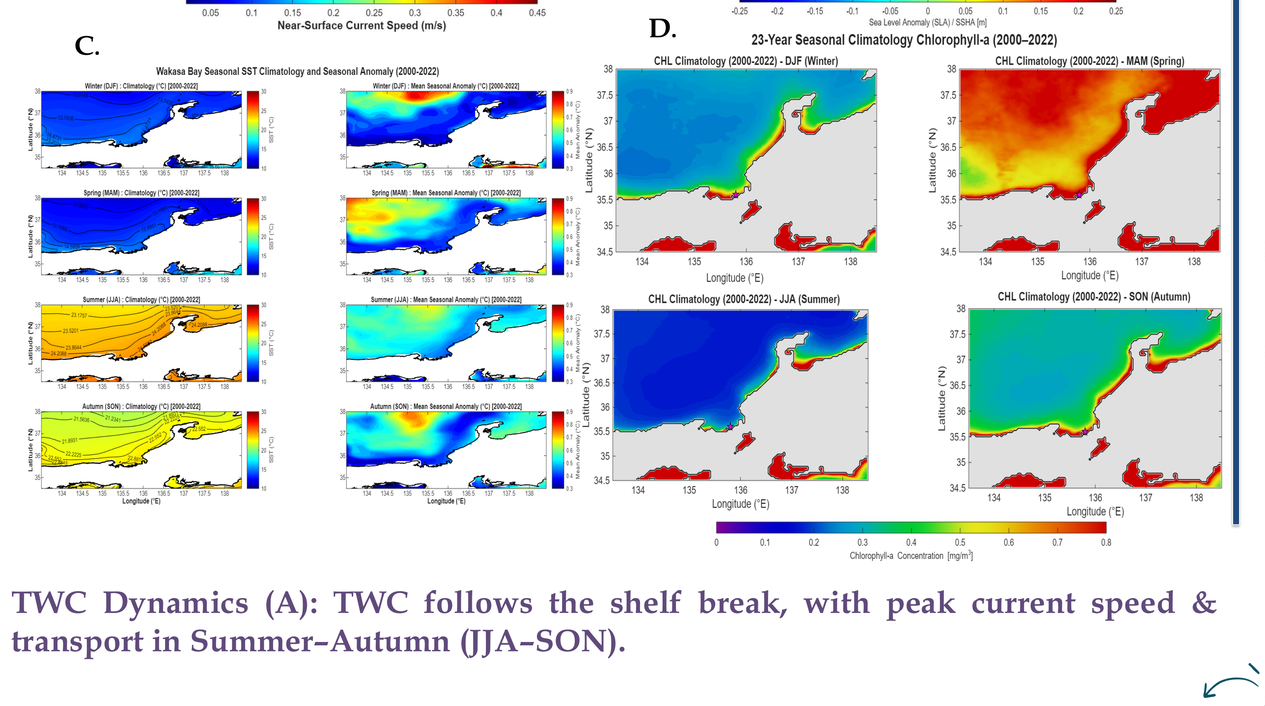
Analytical Steps

1. Monthly Climatology (2000–2022)
2. Subtract from Daily Data → Seasonality-Free Anomaly
3. Wider Region Analysis & Animation
4. Extract Along-Coast Data (Clockwise around Japan)
5. Hovmöller Plots (SSHA, Chla, Velocity Anomaly)

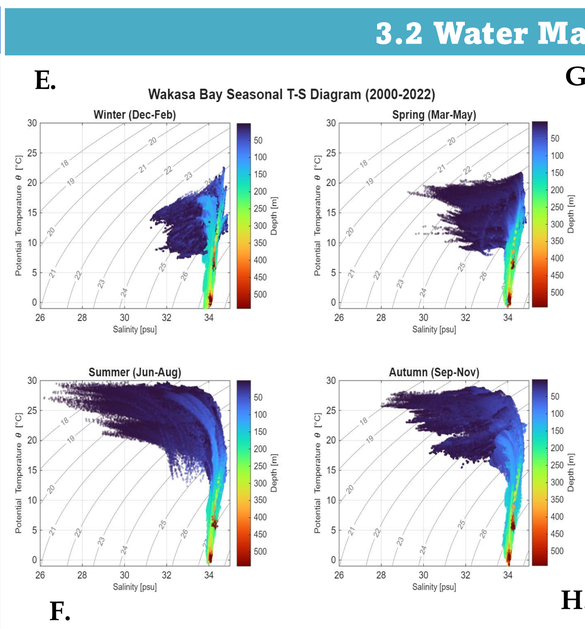
3. Results

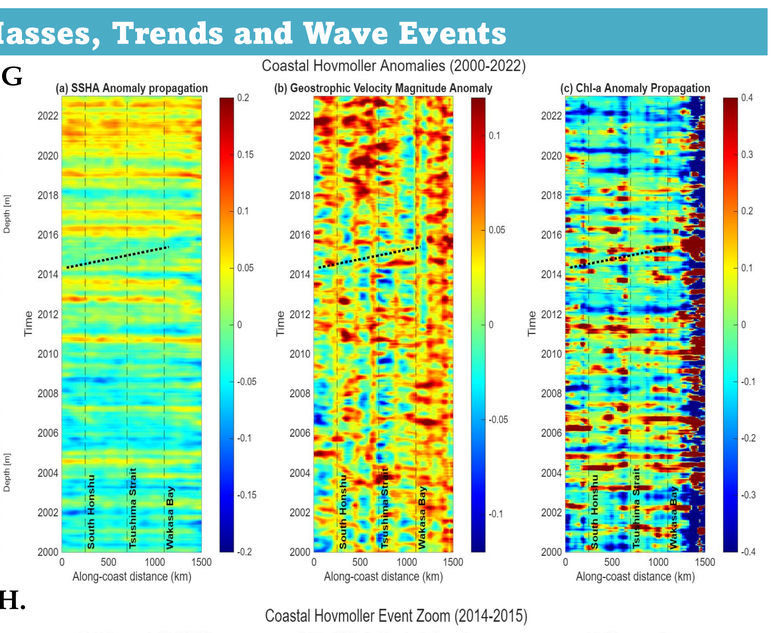
3.1 Climatology and Hydrographic Baseline

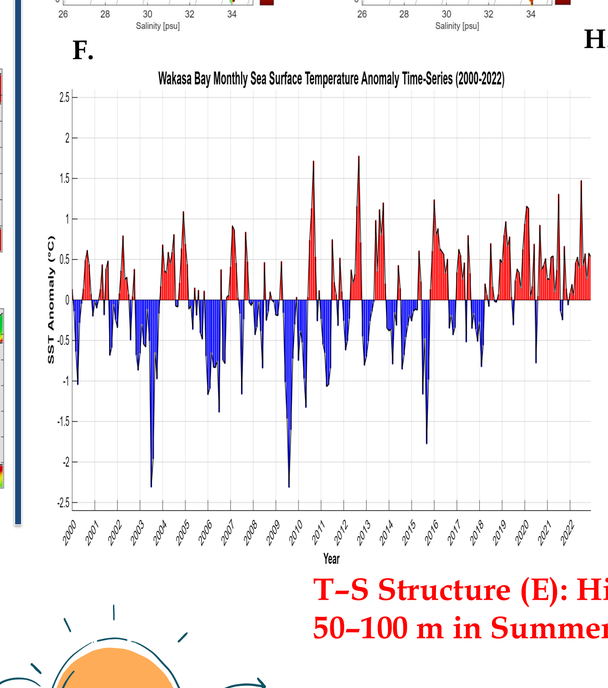


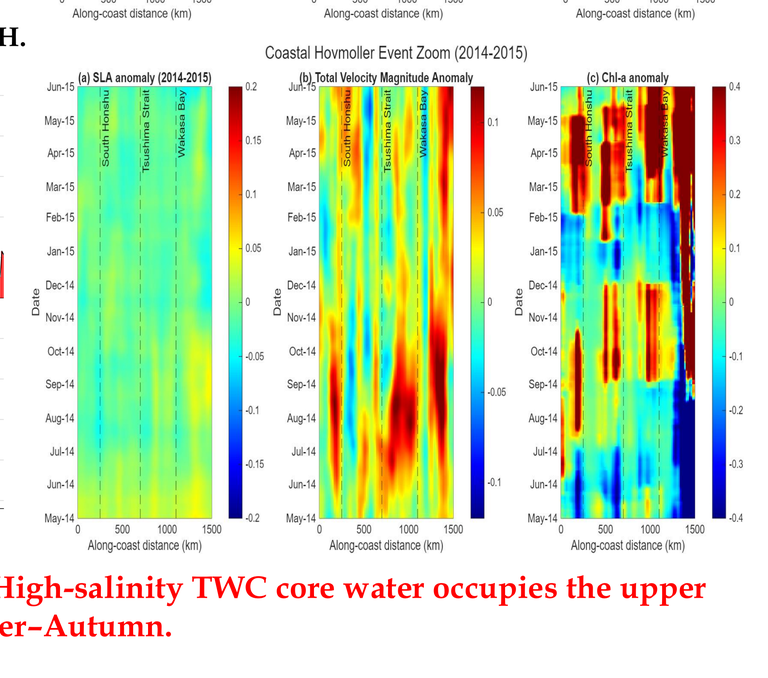


3.2 Water Masses, Trends and Wave Events









TWC Dynamics (A): TWC follows the shelf break, with peak current speed & transport in Summer–Autumn (JJA–SON).

Sea Level (B): Elevated Autumn SSHA follows the TWC pathway toward Wakasa Bay.

Thermal Structure (C): Strong Summer warming, with SST >24°C across Wakasa Bay.

Biological Productivity (D): Major Spring Chl-a bloom, followed by Summer stratification & nutrient depletion.



Summary of Figures

T–S Structure (E): High-salinity TWC core water occupies the upper 50–100 m in Summer–Autumn.

SST Variability (F): Strong interannual variability, with warm peaks in 2010, 2012–13 & 2020–22.

Full-period (2000-2022) anomalies (G) confirm that coastal signals originate south of Honshu and propagate clockwise to directly modulate the Tsushima Current.

The 2014-2015 event (H) shows The wave pushes the Tsushima Current and Chl-a together directly into Wakasa Bay.

4. Conclusions

- Long-term records show wave signals move clockwise around Japan from South Honshu.
- Although the correlation is not statistically significant, velocity and Chl-a positive anomalies are visually correlated, propagating from Tsushima Strait to Wakasa Bay

5. Future Work

- Future work will determine if this propagation is driven by Coastal Trapped Waves (CTWs) or mesoscale fluctuations.
- Integrate with biological data (e.g., Chl-a, fisheries).
- Use CROCO model for process-based understanding.

6. Acknowledgments

Supported by the MEXT Scholarship, the TUMSAT WISE Program, and supervision from Prof. Takeyoshi Nagai, with datasets provided by Copernicus Marine Service (CMEMS).

7. Reference

Ministry of the Environment, Japan (MOE). Wakasa Bay — Ecologically or Biologically Significant Marine Areas. https://www.env.go.jp/en/nature/biodic/kaiyo-hozen/kaiiki/engan/16301.html

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